WHAT IS CLAIMED IS:

We claim:

1. A variable speed transmission, comprising:

a longitudinal axis;

a plurality of balls distributed radially about the longitudinal axis, each ball having a tiltable axis about which it rotates;

a rotatable input disc positioned adjacent to the balls and in contact with each of the balls;

a rotatable output disc positioned adjacent to the balls opposite the input disc and in contact with each of the balls;

a rotatable idler having a substantially constant outer diameter coaxial about the longitudinal axis and positioned radially inward of and in contact with each of the balls; and

a planetary gear set mounted coaxially about the longitudinal axis of the transmission.

2. The variable speed transmission of Claim 1, wherein the balls sum a torque component transmitted from at least two power paths, which power paths are provided by the planetary gear set and wherein the at least two power paths are coaxial.

3. The variable speed transmission of Claim 1, wherein at least one of the idler and the output disc provide a torque input to the planetary gearset.

4. The variable speed transmission of Claim 1, wherein the idler has an irregular interior bore, and wherein the idler is supported in its radial position by first and second shift guide sleeves, which fit coaxially within the interior bore, and is further supported by first and second radial support bearings positioned between the each end of the idler interior bore and its respective guide sleeve.

5. The variable speed transmission of Claim 4, wherein the transmission is shifted by axially moving the guide sleeves.

6. The variable speed transmission of Claim 1, wherein the planetary gearset further comprises:

a ring gear mounted coaxially about the longitudinal axis and having teeth that face radially inward towards;

a plurality of planet gears distributed coaxially about the longitudinal axis within the ring gear and in engagement with the ring gear, each planet gear having a respective planet axis about which it rotates, and wherein the planet axes are located radially away from the longitudinal axis;

a plurality of planet shafts, one for each planet, about which the planet gears rotate;

a sun gear mounted coaxially about the longitudinal axis and radially within and in engagement with each of the plurality of planet gears; and

a planet carrier mounted coaxially about the longitudinal axis and adapted to support and position the planet shafts.

7. The variable speed transmission of Claim 6, further comprising a cage adapted to align the tiltable axes of the balls and further adapted to maintain the angular and radial positions of the balls.

8. The variable speed transmission of Claim 7, wherein at least one of the idler, the cage and the output disc provide a torque input to the planetary gearset.

9. The variable speed transmission of Claim 7, wherein an input torque is supplied to the planet carrier and the planet carrier is coupled to the input disc, wherein the sun gear is coupled to the cage, wherein the ring gear is fixed and does not rotate, and wherein an output torque is supplied from the transmission by the output disc.

10. The variable speed transmission of Claim 6, further comprising an axial force generator adapted to generate an axial force that increases the traction between the input disc, the balls, the idler and the output disc.

11. The variable speed transmission of Claim 10, wherein an amount of axial force generated by the axial force generator is a function of the transmission ratio of the transmission.

12. The variable speed transmission of Claim 11, wherein each of the input disc, the balls, the output disc, and the idler have contact surfaces that are coated with a friction increasing coating material.

13. The variable speed transmission of Claim 12, wherein the coating material is a ceramic.

14. The variable speed transmission of Claim 12, wherein the coating material is a cermet.

15. The variable speed transmission of Claim 12, wherein the coating is a material selected from the group consisting of silicon nitride, silicon carbide, electroless nickel, electroplated nickel, or any combination thereof.

16. The variable speed transmission of Claim 12, wherein the thickness of the coating material is between .25 and 5 microns.

17. The variable speed transmission of Claim 12, wherein the thickness of the coating material is between .5 and 4 microns.

18. A variable speed transmission, comprising:

a longitudinal axis;

a plurality of balls distributed radially about the longitudinal axis, each ball having a tiltable axis about which it rotates;

a rotatable input disc positioned adjacent to the balls and in contact with each of the balls;

a fixed output disc positioned adjacent to the balls opposite the input disc and in contact with each of the balls;

a rotatable idler having a constant outside diameter and positioned radially inward of and in contact with each of the balls;

a cage, adapted to maintain the radial position and axial alignment of the balls and that is rotatable about the longitudinal axis; and

an idler shaft connected to the idler adapted to receive a torque output from the idler and transmit the torque output out of the transmission.

19. The variable speed transmission of Claim 18, further comprising an axial force generator adapted to generate an axial force that increases the traction between the input disc, the balls, the idler and the output disc.

20. The variable speed transmission of Claim 19, wherein an amount of axial force generated by the axial force generator is a function of the transmission ratio of the transmission.

21. The variable speed transmission of Claim 20, wherein each of the input disc, the balls, the output disc, and the idler have contact surfaces that are coated with a friction increasing coating material.

22. The variable speed transmission of Claim 21, wherein the coating material is a ceramic.

23. The variable speed transmission of Claim 21, wherein the coating material is a cermet.

24. The variable speed transmission of Claim 21, wherein the coating is a material selected from the group consisting of silicon nitride, silicon carbide, electroless nickel, electroplated nickel, or any combination thereof.

25. The variable speed transmission of Claim 21, wherein the thickness of the coating material is between .25 and 5 microns.

26. The variable speed transmission of Claim 21, wherein the thickness of the coating material is between .5 and 4 microns.

27. A variable speed transmission, comprising:

a longitudinal axis;

a first plurality of balls distributed radially about the longitudinal axis, each ball having a tiltable axis about which it rotates;

a second plurality of balls distributed radially about the longitudinal axis, each ball having a tiltable axis about which it rotates;

a first rotatable input disc positioned adjacent to the first plurality of balls and in contact with each of the first plurality of balls;

a second rotatable input disc positioned adjacent to the second plurality balls and in contact with each of the first plurality of balls;

an input shaft coaxial with the longitudinal axis and connected to the first and second input discs;

a rotatable output disc positioned between the first and second pluralities of balls and in contact with each of the first and second pluralities of balls;

a first generally cylindrical idler positioned radially inward of and in contact with each of the first plurality of balls; and

a second generally cylindrical idler positioned radially inward of and in contact with each of the second plurality of balls.

28. The variable speed transmission of Claim 27, further comprising an axial force generator adapted to generate an axial force that increases the traction between the input disc, the balls, the idler and the output disc.

29. The variable speed transmission of Claim 28, wherein an amount of axial force generated by the axial force generator is a function of the transmission ratio of the transmission.

30. The variable speed transmission of Claim 29, wherein each of the input disc, the balls, the output disc, and the idler have contact surfaces that are coated with a friction increasing coating material.

31. The variable speed transmission of Claim 30, wherein the coating material is a ceramic.

32. The variable speed transmission of Claim 30, wherein the coating material is a cermet.

33. The variable speed transmission of Claim 30, wherein the coating is a material selected from the group consisting of silicon nitride, silicon carbide, electroless nickel, electroplated nickel, or any combination thereof.

34. The variable speed transmission of Claim 30, wherein the thickness of the coating material is between .25 and 5 microns.

35. The variable speed transmission of Claim 30, wherein the thickness of the coating material is between .5 and 4 microns.

36. A rolling traction variable speed transmission, comprising:

a longitudinal axis;

a plurality of round speed adjusters distributed about the longitudinal axis, each speed adjuster having a tiltable axis about which it rotates;

an input disc that is coaxial with and rotatable about the longitudinal axis and that is positioned adjacent to and in contact with each of the speed adjusters;

an output disc that is coaxial with and rotatable about the longitudinal axis and that is positioned adjacent to and in contact with each of the speed adjusters; and

an axial force generator adapted to apply an axial force to increase contact force between the input disc, the output disc and the plurality of speed adjusters, the axial force generator further comprising;

a bearing disc coaxial with and rotatable about the longitudinal axis having an outer diameter and an inner diameter and having a threaded bore formed in its inner diameter;

a plurality of perimeter ramps attached to a first side of the bearing disc near its outer diameter;

a plurality of bearings adapted to engage the plurality of bearing disc ramps;

a plurality of input disc perimeter ramps mounted on the input disc on a side opposite of the speed adjusters adapted to engage the bearings;

a generally cylindrical screw coaxial with and rotatable about the longitudinal axis and having male threads formed along its outer surface, which male threads are adapted to engage the threaded bore of the bearing disc;

a plurality of central screw ramps attached to an end of the screw facing the speed adjusters; and

a plurality of central input disc ramps affixed to the input disc and adapted to engage the plurality of central screw ramps.

37. The rolling traction variable speed transmission, of Claim 36, wherein the axial force generator further comprises:

a thrust bearing contacting the end of the screw,

a linkage assembly positioned along the longitudinal axis and adapted to apply an axial force to the thrust bearing tending to move the screw axially away from the input disc in response to a shift in the transmission ratio, wherein when the transmission is shifted, the linkage assembly applies an appropriate amount of axial force to the thrust bearing as a function of the transmission ratio.

38. A support cage that supports and positions a plurality of speed adjusting tiltable balls in a rolling traction transmission, which utilizes an input disc and an output disc on either side of the plurality of balls, the cage comprising:

first and second flat support discs that are each a generally circular sheet having a plurality of slots extending radially inward from an outer edge, each slot having two sides; and

a plurality of flat supporting spacers extending between said first and second support discs each spacer having a front side, a back side, a first end and a second end;

wherein the first and second ends each have a mounting surface, wherein each mounting surface has a curved surface, and wherein the spacers are positioned angularly about the support discs between the grooves in the support discs such that the curved surfaces are aligned with the sides of the grooves.

39. A support leg for a ratio changing mechanism, which changes the transmission ratio in a rolling traction transmission by tilting an axle that forms the axis of rotation of a ratio-determining ball, wherein the leg comprises:

an elongated body;

an axle-connecting end;

a cam end opposite the axle-connecting end;

a front side that faces the ball and a backside that faces away from the ball; and

a central support portion between the axle-connecting end and the cam end;

wherein the axle-connecting end has a bore formed through it adapted to receive the axle, and wherein a convexly curved camming surface is formed on the front side of the cam end that is adapted to assist in controlling the alignment of the bore.

40. A fluid pumping ball for use in a variable speed rolling traction transmission utilizing a plurality of balls rotatable about their respective tiltable axes, an input disc on one side of and in contact with each of the plurality of balls, and an output disc on another side of and in contact with each of the plurality of balls, the fluid pumping ball comprising:

a spherical ball having a bore formed through a diameter of the ball creating a cylindrical inner surface through the ball; and

at least one helical groove formed in the inner surface of the ball and extending through the ball.

41. A fluid pumping axle for use in a variable speed rolling traction transmission utilizing a plurality of balls having respective axes formed by diametrical bores formed therethrough, an input disc on one side of and in contact with each of the plurality of balls, and an output disc on another side of and in contact with each of the plurality of balls, the fluid pumping axle comprising:

a generally cylindrical axle of a diameter smaller than that of the bore through the balls and having first and second ends and a middle region, wherein when the axle is positioned properly within the bore of its respective ball, the first and second ends extend out of opposite sides of the ball and the middle region resides within the ball; and

at least one helical groove formed on an outside surface of the axle, wherein the helical groove begins at a point outside of the ball and extends into at least a portion of the middle region.

42. The fluid pumping axle of Claim 41, wherein the at least one helical groove further comprises acme threading.

43. The fluid pumping axle of Claim 41, wherein the acme threading extends past the side of the ball a distance of from 0.5 thousandths of an inch to 2 inches.

44. The fluid pumping axle of Claim 41, wherein the acme threading extends past the side of the ball a distance of from 10 thousandths of an inch to one inch.

45. The fluid pumping axle of Claim 44, further comprising a reservoir area formed in a portion of the middle region.

46. A shifting mechanism for a variable speed rolling traction transmission having a longitudinal axis and that utilizes a plurality of tilting balls distributed in planar alignment about the longitudinal axis and each ball contacted on opposing sides by an input disc and an output disc, in order to control a transmission ratio of the transmission, the shifting mechanism comprising:

a tubular transmission axle running along the longitudinal axis;

a plurality of ball axles each extending through a bore formed through a corresponding one of the plurality of balls and forming a tiltable axis of the corresponding ball about which that ball spins, and each ball axle having two ends that each extend out of the ball;

a plurality of legs, one leg connected to each of the ends of the ball axles, the legs extending radially inward toward the transmission axle;

an idler having a substantially constant outside diameter that is positioned coaxially about the transmission axle and radially inward of and in contact with each of the balls;

two disc-shaped shift guides, one on each end of the idler, and each having a flat side facing the idler and a convex curved side facing away from the idler, wherein shift guides extend radially to contact all of the respective legs on the corresponding side of the balls;

a plurality of roller pulleys, one for each leg, wherein each roller pulley is attached to a side of its respective leg facing away from the balls;

a generally cylindrical pulley stand extending axially from at least one of the shift guides;

a plurality of guide pulleys positioned radially about and attached to the pulley stand; and

a flexible tether having first and second ends with the first end extending through the axle and out a slot, which is formed in the axle proximate to the pulley stand, the first end of the tether further wrapping around each of the roller pulleys and each of the guide pulleys, wherein the second end extends out of the axle to a shifter, wherein the guide pulleys are each mounted upon one or more pivot joints to maintain alignment of each guide pulley with its respective roller pulley and wherein when the tether is pulled by the shifter, the second end draws each of the roller pulleys in to shift the transmission.

47. A shifting mechanism for a variable speed transmission having a longitudinal axis and that utilizes a plurality of tilting balls, each having a ball radius from respective ball centers, in order to control a transmission ratio of the transmission, comprising:

a plurality of ball axles each extending through a bore formed through a corresponding ball and forming the tiltable axis of the corresponding ball, and each ball axle having two ends that each extend out of the ball;

a plurality of legs, one leg connected to each of ends the ball axles, the legs extending radially inward toward the transmission axle;

a generally cylindrical idler with a substantially constant radius positioned coaxially and radially inward of and in contact with each of the balls;

first and second disc-shaped shift guides, one on each end of the idler, and each having a flat side facing the idler and a convex curved side facing away from the idler, wherein shift guides extend radially to contact all of the respective legs on the corresponding side of the balls; and

a plurality of guide wheels each having a guide wheel radius, one guide wheel for each leg, each guide wheel rotatably mounted at a radially inward end of its respective leg, wherein the guide wheels contact the curved surface of its respective shift guide;

wherein respective shapes of the convex curves are determined by a set of two-dimensional coordinates, the origin of which is centered at the intersection of the longitudinal axis and a line drawn through the centers of any two diametrically opposing balls, wherein the coordinates represent the location of the point of contact between the guide wheel surface and the shift guide surface as a function of the axial movement of the idler and shift guide, assuming that the convex curve is substantially tangent to the guide wheel at the point of contact.

48. The shifting mechanism of Claim 47, wherein the shapes of the convex curves are also a function of the radii of the balls and the radii of the guide wheels.

49. The shifting mechanism of Claim 48, wherein the shapes of the convex curves are also a function of the radius of the idler.

50. An aoutomobile, comprising:

an engine;

a drivetrain; and

a variable speed transmission comprising;

a longitudinal axis;

a plurality of balls distributed radially about the longitudinal axis, each ball having a tiltable axis about which it rotates;

a rotatable input disc positioned adjacent to the balls and in contact with each of the balls;

a rotatable output disc positioned adjacent to the balls opposite the input disc and in contact with each of the balls;

a rotatable idler having a substantially constant outer diameter coaxial about the longitudinal axis and positioned radially inward of and in contact with each of the balls; and

a planetary gear set mounted coaxially about the longitudinal axis of the transmission.

51. A coasting mechanism for a rolling traction transmission coupled to a rotating prime mover, which transmission utilizes a plurality of speed adjusting tiltable balls between opposing input and output discs to control a transmission ratio, the coasting mechanism comprising:

a connector extending from a side of the input disc opposite the balls, wherein the connector has a first end and a second end, the first end of the connector rigidly attached to the input disc, the second end extending from the input disc

a clutch lever having a first clutch end, a second clutch end and a middle portion, the first clutch end operably engaged with the second end of the connector, the second clutch end attached to a pawl, the middle portion having an aperture therethrough, which forms a fulcrum that is adapted to provide an axis about which the clutch lever can pivot;

an elongated resilient rod adapted to hold the clutch lever, the resilient rod having an outside size that is smaller than the aperture of the clutch lever so that the clutch lever may rotate freely, wherein the resilient rod is adapted to rotate at a slower speed than the input disc when the input disc is rotating and the input torque has stopped, and wherein the resilient rod rotates at a slower speed than the prime mover when prime mover has resumed and the input disc is not rotating;

at least one ratcheting disc having teeth formed on its outer diameter and having a hole formed through its center through which the resilient rod extends;

at least one pawl mounted to the second end of the clutch lever and adapted to engage the teeth of the at least one ratcheting disc;

wherein an application of an input torque from the prime mover subsequent to previous cessation of an input torque causes the ratchet disc to rotate, thereby

releasing the pawl and allowing the clutch lever to pivot and causing the connector to move to maintain contact with the clutch lever thereby causing the input disc to rotate in a direction such that it comes into contact with the balls.